SITE NEED STATEMENT

General Reference Information

Need Title: **Long-Term, Monolayer Arid Site Closure Cover - Enhanced Usability**
Need Code: NV12-0101-09S
Need Summary: Several sites, both on and off the NTS (e.g., Sandia National Laboratories, Los Alamos National Laboratory, Idaho National Energy and Environmental Laboratory, and the Hanford Nuclear Reservation), will require the installation of closure covers that will need to perform satisfactorily for up to 1,000 years. Specific southwest U.S. conditions include an arid/semi-arid desert setting with an expected subsidence of the waste zone and overlying closure cover. Cover designs need to include soil-physical features that maximize evapotranspiration, mitigate biointrusion, and concurrently accommodate subsidence and resultant potential focused infiltration.

Traditional RCRA landfill closure covers were designed primarily for locations with wet climatic conditions. Use of the traditional RCRA closure cover design is economically undesirable at an arid/semi-arid disposal location based on poor long-term performance characteristics and the associated high level of maintenance that would be required to sustain such a cover's integrity. Smectitic clays used in many RCRA designs swell and shrink with alternating wetting and drying conditions. In arid/semi-arid conditions, the shrinking could be enough to result in cracking which limits the engineered barriers ability to reduce infiltration. In addition, anticipated subsidence would tend to disrupt the overall integrity of a traditional layered RCRA cover and could result in open fractures. Open fractures would be a catastrophic failure of the biointrusion barrier and would also tend to focus infiltration. Due to the nature of disposed wastes, closure cover integrity must be maintained at DOE's disposal locations in order to provide for an appropriate level of long-term stewardship.
Origination Date: January 1, 2001
Need Type: Science Need
Operations Office: DOE/NV
Geographic Site Name: Nevada Test Site and other western DOE disposal sites
Project: NV370/Low-Level Waste (LLW)
National Priority: Medium
Operations Office Priority: 9 of 12

Problem Description Information

Operations Office Program Description: The primary mission of the DOE/NV Waste Management Program is to manage radioactive and hazardous waste generated by DOE and defense industry activities that is stored or disposed at the Nevada Test Site. The Waste Management Program must ensure that the acceptance, treatment, storage, and/or disposal of waste is carried out in accordance with federal, state, and local regulations.

Need/Problem Description: Design, develop, and implementation of long-lived, cost-effective closure covers for disposal units in arid west conditions is needed to enhance the long-term control of disposed waste. The nature and requirements of the final closure cover are dependent on climatic conditions, the waste cell inventory, conceptual models of the vadose zone including subsidence processes, and limitations associated with schedule and budget. Use of Long-Term, Monolayer Arid Site Closure Covers (also referred to as Evapotranspiration or ET Covers) in arid/semi-arid climatic conditions such as the Nevada Test Site (NTS) and other western sites within the DOE complex, will minimize cap maintenance during the long-term stewardship periods that will follow landfill closures. The monolayer, or ET cover takes advantage of natural evapotranspiration processes which remove water through evaporation and plant transpiration. The cap serves as a device to store water until evapotranspiration processes have sufficient time to remove the water.
Long-Term, Monolayer Arid Site Closure Covers would take advantage of largely favorable environmental conditions at arid/semi-arid locations. The caps would be designed to:

- Maximize evapotranspiration
- Minimize the already negligible potential for groundwater recharge

- Accommodate subsidence
- Mitigate biointrusion

The impending construction of the ET cover at the U-3ax/bl disposal cell represents this technology becoming the baseline for closure of other LLW cells at the NTS. Performance data collected from the first closure will be fed back into the design and construction of other ET covers at the NTS. However, additional information on long-term evolution (100 to 1000 years) of these covers as landform features that change because of pedogenic, biotic, and climatic processes could also be used to enhance ET cover designs here and at other DOE sites. In addition, work on enhancement to ET covers, such as with engineered clays, could make them acceptable closure alternatives at sites that receive greater precipitation than the NTS.

Functional Performance Requirements:

While the performance of alternative covers is sure to be adequate for the short term, the long-term impacts of waste zone subsidence on the physical and biological integrity and hydrologic performance of covers is uncertain and needs further study. There is limited information on the dynamics of subsidence and the relations between subsidence and processes of moisture accumulation, focused infiltration, and biointrusion.

Alternative closure covers must improve overall performance over standard RCRA covers including:

- Increased resistance to shrinking, cracking.
- Increased survivability for limiting infiltration.
- Increased survivability as a biointrusive barrier.
- Withstand wide variations in daytime/nighttime temperatures.
- Withstand the wide seasonal temperature regime of 30-120F.
- Withstand strong solar radiation.
- Effective life of approximately 100 years, but up to 1,000 years.
- Effective high evapotranspiration ability.
- Accommodate subsidence with a minimal change in cover performance.
- Reduced maintenance.
- Reduced life-cycle cost.
- Minimal use of non-native materials.

Definition of Solution: Use of Long-Term, Monolayer Arid Site Closure Covers (also referred to as Evapotranspiration or ET Covers) in arid/semi-arid climatic conditions such as the Nevada Test Site (NTS) and other western sites within the DOE complex, to minimize cap maintenance during the long-term stewardship periods that will follow landfill closures.

Targeted Focus Area: Subsurface Contaminants

Potential Benefits: Conventional closure covers will have decreased longevity, have a significantly higher cost for construction, and would likely require more frequent inspection, maintenance, and/or replacement.

Potential Cost Savings: $9,000 per acre

Potential Cost Savings Narrative: When compared to the estimate for a multi-layer RCRA cover, the cost savings over a 100-year period (period selected for comparison purposes only), including construction and maintenance, is approximately $919,000 per acre. Monitoring costs are not included in the savings potential as those costs are site specific and subject to negotiations with respective State regulators.

Technical Basis: Traditional cover designs use materials that may not have sufficient durability for long-term applications and may not perform well under subsided conditions. With time, the cover may break down and/or subside, resulting in an increased potential for ponding of water in surface depressions and resultant focused infiltration, enhanced biointrusion, and increased rates of gaseous diffusion from the waste to the surface. Cover designs for arid conditions could rely upon soil water storage, and plant water uptake and transpiration to reduce downward movement of water from the cover through the disposed waste.

The need for this technology, along with the need for performance data on a long-lived, cost-effective closure cover for conditions that are specific to arid sites, was recognized for NTS Radioactive Waste Management Site disposal cells. This recognition has resulted in the impending deployment of an ET cover at the U3ax/bl disposal cell at the Area 3 Radioactive Waste Management Site (RWMS) on the NTS. The deployment of

	this technology anticipated to support, and enhance the long-term stewardship capabilities of radioactive waste disposal facilities at the NTS. The systematic closure of inactive disposal cells on the NTS, using the ET cover, will start with U3ax/bl at the Area 3 RWMS. Lessons learned during this initial closure will be incorporated in future deployments on other disposal cells at both the Area 3, and Area 5 RWMS.
Cultural/Stakeholder Basis:	Releases from disposal units would have negative impacts on regulator and stakeholder perception of the disposal system performance adequacy. This negative perception would likely exist regardless of whether or not the release violated performance limits. Excessive expenditures for the maintenance of inappropriate closure covers would also likely promote negative perceptions of the long-term management of closed disposal locations. Closure covers that perform without failure and without extensive maintenance funding, would at the very least be "out-of-sight and out-of-mind," and could lead to enhanced regulator and stakeholder confidence in DOE's ability to provide for long-term stewardship of its disposal sites.
Environment, Safety, and Health Basis:	Failed disposal unit closure covers could result in significant safety, health, and environmental issues. Extreme subsidence could lead to the release of radionuclides to the atmosphere and/or groundwater. The primary mechanism for cover failure is anticipated to be primarily due to subsidence. Failed closure covers could: • Subject personnel to radiation • Focus water infiltration through the waste • Increase the potential for groundwater recharge • Increase the potential for ground water contamination
Regulatory Drivers:	Performance assessments require an evaluation of long-term performance of a waste disposal system. However, current performance studies show that the NTS disposal sites meet performance objectives without a closure cover (operational cover only). A closure cover design is needed that meets requirements of sound engineering and that degrades with time in a manner that does not unreasonably reduce the performance of the disposal system.
Milestones:	Not applicable.
Material Streams:	LLW Sludge, Contaminated Soils & Liquid (1019); Technical risk score 3. Not on critical path to closure. For Industrial Sites, includes inactive tanks, drains and sumps, spill sites, material disposal sites, decontamination sites, and D&D facilities; for LLW and mixed LLW includes drums, cargo containers, crates, and "burrito sacks".
TSD System:	Includes engineered caps and covers, in place solidification, and covers constructed over contaminants left in place (e.g., GCD disposal). On site treatment of a limited amount of TRU waste at the Waste Examination Facility prior to shipment to WIPP. No other on-site treatment of waste except for sizing of material to place in waste containers (e.g., D&D wastes).
Major Contaminants:	For Industrial Sites, includes organic and inorganic chemicals, petroleum products, metals, unexploded ordnance and related contaminants, and radionuclides including tritium, mixed fission products, and actinides (although at levels below classification of waste as TRU waste).
Contaminated Media:	Soil, concrete, construction material, sludges (e.g., at industrial sites), paper, etc. Soil and sludges are the only waste forms not in containers (from Industrial Sites closed in place).
Volume/Size of Contaminated Media:	Mixed Low Level Waste: 230 cubic meters; Low Level Waste: 365,453 cubic meters; Industrial Site Waste: 11,209 cubic meters (mostly hazardous waste).
Earliest Date Required:	2001
Latest Date Required:	2002

Baseline Technology Information

Baseline Technology Process:	The DOE/NV Waste Management Division Baseline currently contains plans and estimates for the deployment of Long-Term, Monolayer Arid Site Closure Covers (ET Cover) on all Waste Management disposal cells to be closed in the future. To the best of our knowledge, the baseline technology planned for use at other radioactive waste management sites not under the responsibility of DOE/NV, is the standard RCRA cover. The primary reasons that may be precluding the application of alternatives to RCRA

	covers at other sites include: the lack of field-generated information on performance; potential problems with regulatory and stakeholder acceptability; and the fact that no landfills have yet been closed using this type of cap. At the NTS, filled waste cells are covered with an operational cover (approximately 8 feet thick), with the intent of adding a final ET closure cover at a later date. However, an ET cover has been approved by the State of Nevada for the closure of the U3ax/bl disposal cell. This disposal cell is listed in the Nevada Test Site RCRA Part A Permit Application. Success in the construction and demonstrated performance of this cover could lead to wider application of ET and other alternative covers at Nevada sites and possibly at other DOE sites.
Life-Cycle Cost Using Baseline:	The cost for construction of an Alternative Technology or ET Cover is estimated to be approximately $192,000 per acre. The annual cost for maintenance of this type of ET closure cap is estimated to be approximately $220 per acre.
Uncertainty on Baseline Life-Cycle Cost:	The cost for construction of a RCRA closure cap similar to those that have previously been applied to units on the NTS is estimated to be approximately $1,045,000 per acre. The annual cost for maintenance of this type of multi-layer RCRA closure cap is estimated to be approximately $880 per acre. This cost baseline would be applicable to an arid site that currently plans to use a similar RCRA cover for the closure of their landfills. As stated previously, the multi-layer RCRA cover is not applicable to the NTS LLW disposal facilities, as the DOE/NV Waste Management Baseline includes plans for the use of the Alternative Technology, or ET Cover. Cost information will be updated as performance and cost data from the deployment of the first ET Cover (on U3ax/bl) becomes available.
Completion Date Using Baseline:	2002

Points of Contact (POC)

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